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DaimlerChrysler AG

Method and device for producing workpieces by means of internal high pressure forming

The present invention relates to a method and a device for simultaneously producing at least two workpieces, separated from one another, by means of internal high pressure forming or hydroforming according to the preambles of the independent claims.

The internal high pressure forming process, also called hydroforming, is based on inserting a blank in the form of a hollow profile, for example a tube, into a forming tool, in sealing off the blank on both sides and in applying an internal high pressure to it in such a way that the blank nestles against a negative mold, at a distance from it, of the forming tool and thus assumes the contours of said mold. In this way, hollow bodies can be produced which on the one hand may have a complicated shape but on the other hand, at high strength, have a small wall thickness and thus a low weight. For reasons of economy, it is expedient to produce a plurality of workpieces simultaneously in one forming tool.

DE 197 16 816 C2 discloses a method and a device of the type mentioned at the beginning. Here, a blank is inserted into a forming tool which, with its inner wall, has at least two negative molds for in each case one of the workpieces and also at least one parting gap. This parting gap is arranged between two respective negative molds, extends all round in the circumferential direction of the workpieces and is defined by two spaced-apart cutting edges. Arranged in the respective parting gap in the known device is a tool part which can be positioned in the parting gap relative to the workpiece. To form the

blank, the tool part is displaced toward the interior of the forming tool to such an extent that an inner contour of the tool part terminates flush with the cutting edges, so that the latter are sunk in the inner wall of the forming tool and are therefore inactive. The forming of the blank in the forming tool is effected with a calibrating pressure, which is selected in such a way that the blank in the negative molds is in full contact with the inner wall and therefore also with the inner contour of the tool part closing the parting gap. After this forming operation, a parting operation is effected, for which the pressure in the hollow body is increased above the calibrating pressure. Whereas the tool part arranged in the parting gap has still withstood the calibrating pressure, it is now displaced outward on account of the higher parting pressure. It is only by this relative adjustment of the tool part that the cutting edges are exposed, as a result of which a section arranged between the cutting edges and therefore between the two workpieces is cut out.

The known device or the known method therefore works with two successive phases. In the first phase, the workpieces are shaped from the blank in a conventional manner, the workpieces still being in one piece with one another after the forming. In the subsequent second phase, by means of an additionally increased internal pressure, the two workpieces are then parted by releasing cutting edges.

The outlay for providing workpiece parts which withstand the calibrating pressure and do not release the cutting edges until at a higher parting pressure is relatively high in this case.

Furthermore, DE 197 47 607 A1 discloses a method and a device for perforating a workpiece, its one side being subjected to a pressure medium under high pressure and its other side being subjected to the action of a punch guided in a tool, and this punch releasing an encircling cutting edge which is formed on the tool and at which the wall is cut under the effect of an increasing high pressure.

The present invention deals with the problem of specifying an improved embodiment for simultaneously producing at least two workpieces, separated from one another, by means of internal high pressure forming or hydroforming, which improved embodiment can be realized in particular in a more cost-effective manner.

According to the invention, this problem is solved by the subject matters of the independent claims. Advantageous embodiments are the subject matter of the dependent claims.

The invention is based on the general idea of already arranging the cutting edges in an exposed manner during the forming of the blank and of carrying out the forming in such a way that the workpieces are parted at the same time. In the method according to the invention, therefore, the parting of the workpieces is integrated in the forming. In this case, the invention utilizes the surprising knowledge that a workpiece part which closes the parting gap and produces a sunk arrangement of the cutting edges is not necessary for the forming of the blank. In the forming tool according to the invention, such tool parts for closing the parting gap are

consequently dispensed with. This results in a simplified and more cost-effective construction for the forming tool.

According to an especially advantageous development, a gap width of the parting gap is dimensioned in such a way that the workpieces are parted at the calibrating pressure, at which the blank is in full contact with the inner wall in the negative molds. With this proposal, the invention in principle pursues a different way of designing the method parameters and the forming tool. In the conventional two-phase procedure, the parting gap is provided and dimensioned in the forming tool in such a way that the desired parting of the at least two workpieces can thus be carried out with a corresponding increase in internal pressure. To this end, the parting gap is closed by means of a suitable tool part for forming the blank. In this case, the holding forces for positioning the workpiece part are selected as a function of the calibrating pressure, which is required for the proper forming of the blank, in such a way that the workpiece part is not adjusted at the calibrating pressure and the cutting edges cannot be exposed during the forming. For the parting operation, such a high parting pressure is then selected that the tool part can be displaced into the gap, the cutting edges can be exposed and the desired section between the two shaped workpieces can be cut out. In contrast to this, the gap width in the case of the invention is selected as a function of the calibrating pressure, to be precise in such a way that the section between the two workpieces is cut out at the same time at the calibrating pressure. In the case of the invention, therefore, the parting gap is not dimensioned arbitrarily or as a function of

geometrical constraints which result from the positioning of the negative molds in the forming tool, but rather as a function of the calibrating pressure. Accordingly, the positioning of the negative molds inside the forming tool depends on the parting gap determined, and not the other way round.

Since the workpieces are already parted at the calibrating pressure in the method according to the invention, a two-stage method is dispensed with, as a result of which the production overall is simplified.

Further important features and advantages of the invention follow from the subclaims, from the drawings and from the associated description of the figures with respect to the drawings.

It goes without saying that the abovementioned features and the features still to be explained below can be used not only in the respectively specified combination but also in other combinations or on their own without departing from the scope of the present invention.

A preferred exemplary embodiment of the invention is shown in the drawings and is described in more detail below, the same reference numerals relating to identical or functionally identical or similar components.

In the drawing, in each case schematically,

figs 1 to 3 show sectional views through a forming tool in the region of a parting gap in different states of a production process.

According to figs 1 to 3, a forming and parting device 1 according to the invention comprises a forming tool 2, which is only partly shown here and has an inner wall 3, likewise only partly shown. Formed on or in this inner wall 3 are at least two negative molds 4 and 5, which each serve to produce a workpiece 6 or 7, respectively, according to the internal high pressure forming or hydroforming process. Formed in the inner wall 3 between two respective negative molds 4, 5 is a parting gap 8 which extends all round in the circumferential direction of the workpieces 6, 7. The parting gap 8 defines the two negative molds 4, 5 and is in turn defined by two spaced-apart cutting edges 9 and 10. In this case, the cutting edges 9 and 10 define a gap width 11 of the parting gap 8.

According to the invention, the cutting edges 9, 10 are arranged in an exposed manner on the inner wall 3. That is to say that the parting gap 8 is open and the cutting edges 9, 10 interrupt the inner wall 3 of the forming tool 2.

A blank 12, which normally has a hollow profile, can be inserted into the forming tool 2.

In addition, the forming and parting device 1 according to the invention has a feed device (not shown here), by means of which a suitable pressure medium, expediently a liquid, in particular a hydraulic oil, can be delivered into the blank 12 and can be acted upon with an appropriate high pressure. Furthermore, in order to actuate and control the feed device, a corresponding control system (likewise not shown) which controls the sequence of the forming and parting operation is

regularly provided.

The forming and parting method according to the invention or the forming and parting device 1 according to the invention works as follows:

First of all the blank 12 is inserted into the forming tool 2. The feed device at the blank 12 is then connected. After that, an internal high pressure can be built up in the blank 12 after the forming tool 2 has been closed.

According to fig. 2, the blank 12 is widened in the process, in the course of which a wall thickness 13 of the blank 12 naturally decreases. Here, fig. 2 shows that instant or state of the forming and parting operation at which or in which the blank 12 is widened to such an extent that an outer contour 14 of the blank 12 comes into full surface contact with the inner contours of the negative molds 4, 5. Full contact of the outer contour 14 of the blank 12 with the inner contours of the negative molds 4, 5 is reliably achieved at a calibrating pressure P_K. At the calibrating pressure P_K, the workpieces 6, 7 are therefore shaped in the negative molds 4, 5. In the state according to fig. 2, however, the shaped workpieces 6, 7 are still in one piece with one another or are connected to one another via a section 15 arranged in between.

During the application of pressure to the blank 12, it may be expedient to constantly increase the internal high pressure to the calibrating pressure P_K. It is important that the calibrating pressure P_K is produced toward the end of the forming operation.

In a preferred embodiment of the present invention, the parting gap 8 is matched to the calibrating pressure P_K in such a way that, at the calibrating pressure P_K, said section 14 is displaced according to fig. 3 into the gap 8 and is accordingly cut free by the cutting edges 9, 10. The section 15 is shaped so as to be closed all round, in a complimentary manner to the parting gap 8. At the calibrating pressure P_K, the section 15 arranged between the workpieces 6, 7 is cut out, which at the same time leads to parting of the two workpieces 6, 7. The workpieces 6, 7 then lie as separate, finish-formed components in the forming tool 2. In this embodiment of the method according to the invention, a combined forming and parting operation is obtained for the simultaneous production of at least the two workpieces 6, 7. In particular, it is not necessary to specifically raise the pressure for parting the workpieces 6, 7. As a result, firstly it becomes simpler to carry out the forming/parting method and secondly the forming/parting device 1 has a simpler construction, so that it can be produced more cost-effectively.

For the design of the forming tool 2, first of all the calibrating pressure P_K which is required in order to bring the blank 12, with its outer side 14, into full contact with the negative molds 4, 5 is determined. When this calibrating pressure P_K is established, the wall thickness 13 remaining in the hollow profile after the forming is determined. The shearing force that is required for cutting off the section 15 from the workpieces 6, 7 at the cutting edges 9, 10 can then be calculated from the residual wall thickness. By means of the shearing force, the requisite gap width 11 at which

the calibrating pressure P_K cuts out the section 15 can then be calculated with reference to the calibrating pressure P_K and the predetermined circumference of the workpieces 6, 7 in the region of the parting gap 8. As soon as the gap width 11 of the parting gap 8 is established, the position of the negative molds 4, 5 on both sides of the parting gap 8 in the forming tool 2 is thus obtained, provided the negative molds 4, 5 each start or end at one of the cutting edges 9, 10.

It may be necessary to vary the parting gap 8 over the circumference, so that the cutting operation takes place as uniformly as possible.

In another embodiment, which is not preferred, the parting gap 8 may also be dimensioned in such a way that the calibrating pressure P_K is not sufficient to drive the section 15 into the parting gap 8 or to cut the section 15 out. For the parting operation, in this embodiment, the internal high pressure is then correspondingly increased above the calibrating pressure P_K.